Alexandria National University
Faculty of Computer and Data Science
Program :Cyber Security
Professor name: Dr. Reem

Social Network Analysis Report — 5G Conspiracy Graph

1. Introduction

This section presents a full structural analysis of a 5G conspiracy Twitter subgraph extracted from the WICO dataset.
The goal is to understand the network behavior of misinformation clusters by examining their connectivity, clustering, influential nodes, and community structure.
The dataset is loaded into Gephi, visualized using ForceAtlas2, and all relevant network metrics are computed and interpreted.

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2. Dataset Overview

The 5G_conspiracy graph represents user-to-user interactions (mentions/retweets/replies) within a misinformation community discussing false narratives about the 5G network.
The dataset includes:

- **Nodes: 93**
- **Edges: 3094**
- **Graph Type: Directed**

This network tends to show tightly connected cores and influential “hub accounts” that drive the misinformation.

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3. Visualization (ForceAtlas2 Layout)

The network was visualized using ForceAtlas2 with the following settings:

- Scaling: 10
- Gravity: 1
- Approximate Repulsion: Enabled
- Threads: Auto

Node size was scaled by degree, and colors were applied according to modularity classes, allowing clusters to be visually separated.

The visualization clearly shows:

- A dense core of highly connected nodes
- Peripheral nodes attached to the core
- Several small communities orbiting the main misinformation cluster

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4. Network Metrics

4.1 Number of Nodes and Edges

- **Nodes: 93**
- **Edges: 3094**
  Higher edge count relative to nodes indicates an active interaction pattern.

4.2 Average Degree

- **Average Degree = 33.269**
- This relatively high value indicates that users in the 5G misinformation network tend to maintain many overlapping and repeated interactions. Such a dense connectivity pattern is typical in conspiracy-driven clusters, where discussions circulate rapidly within tightly engaged groups, allowing misinformation to spread quickly and remain active across the network

Average Degree 33.269 Run

4.3 Graph Density

- **Density = 0.362**

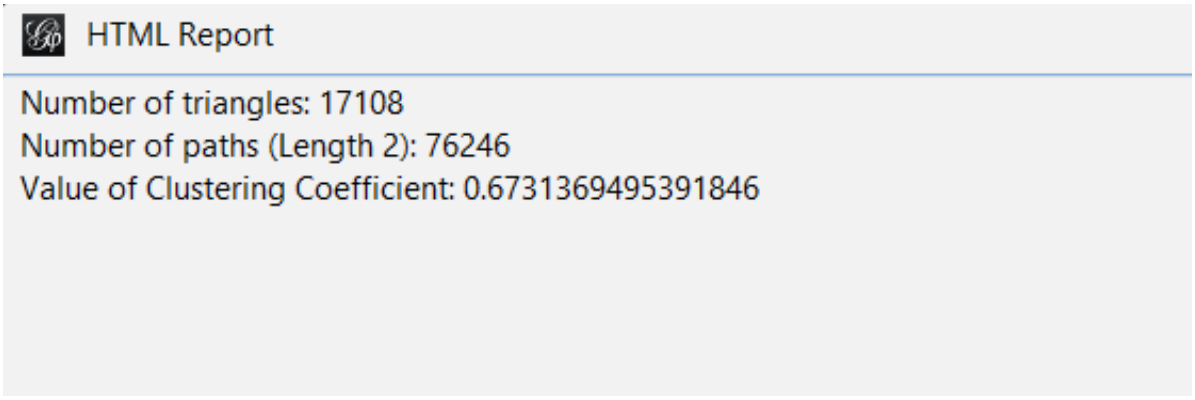
This is considered a remarkably high density for a Twitter-based network.
In typical online social graphs, density usually remains extremely low due to the vast number of possible connections compared to the number of actual interactions.
However, the 5G conspiracy network shows a much higher-than-normal density, indicating that users inside this misinformation cluster are highly interconnected.
Such behavior suggests a tightly bonded discussion environment where many participants repeatedly interact with each other, allowing misinformation to circulate quickly and remain

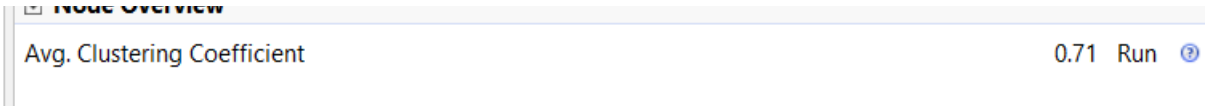
active within the group

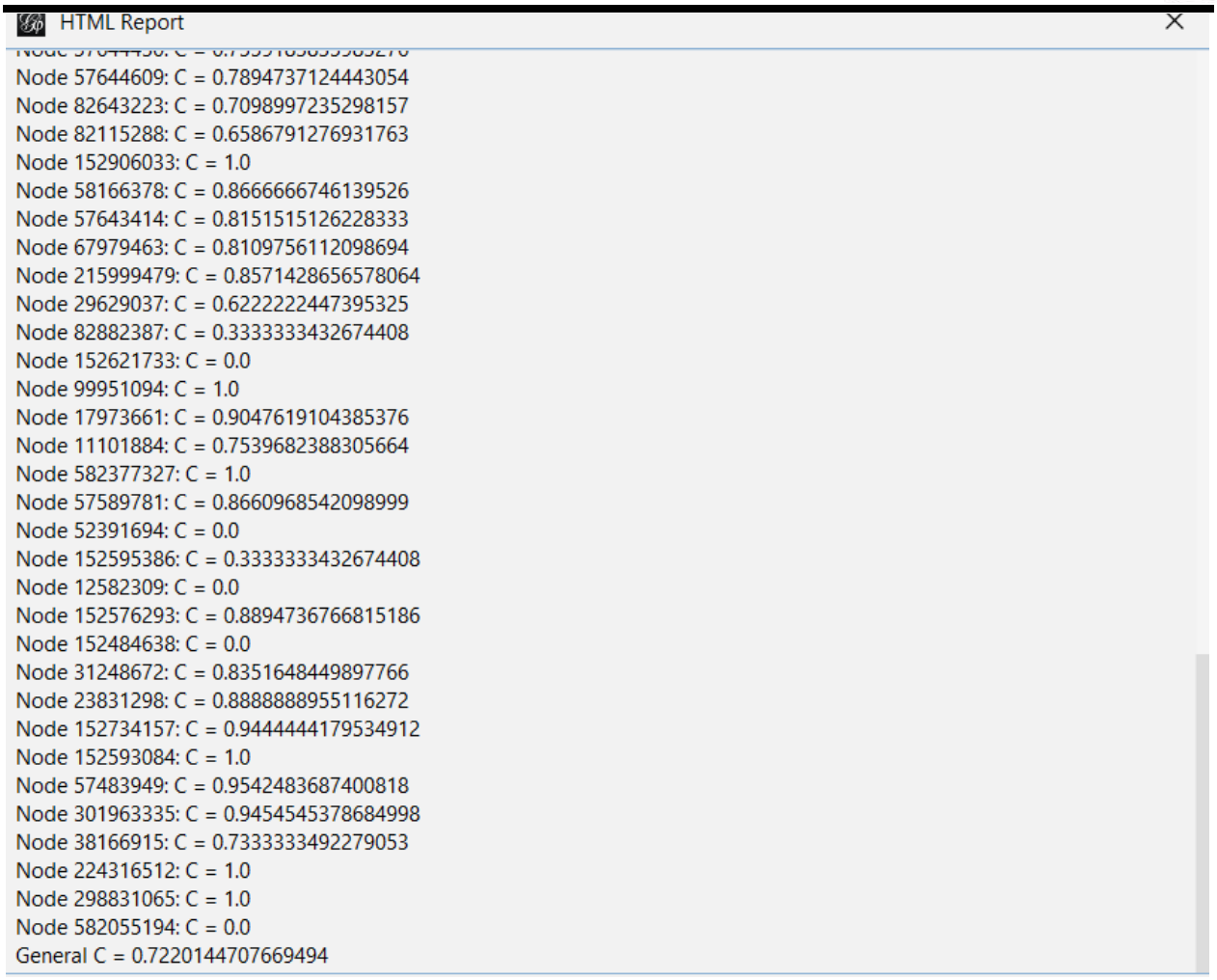
4.4 Average Clustering Coefficient

- **Clustering Coefficient (Network Overview) = 0.71**
- **Clustering Coefficient (Triangles-based) = 0.6731**
- **Number of triangles = 17,108**
- **Number of 2-length paths = 76,246**

The clustering coefficient of approximately 0.71 indicates a highly cohesive structure within the 5G conspiracy network.
This high value reflects dense local connectivity, where users frequently interact with others who are also interconnected.
Such tight-knit interaction circles are typical in misinformation environments, allowing false narratives to be repeatedly reinforced and echoed within small communities before spreading outward.
The large number of triangles observed (17,108) demonstrates strong group cohesion, enabling persistent and rapid circulation of conspiracy content.





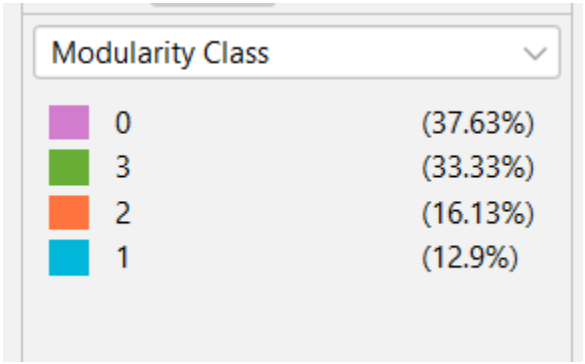


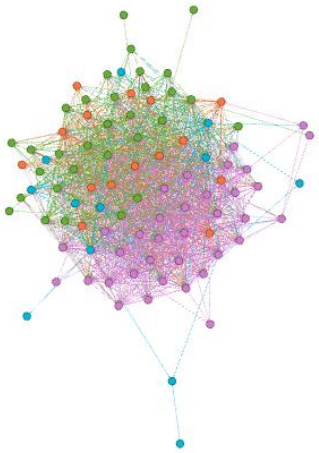
4.5 Modularity (Q) & Number of Communities

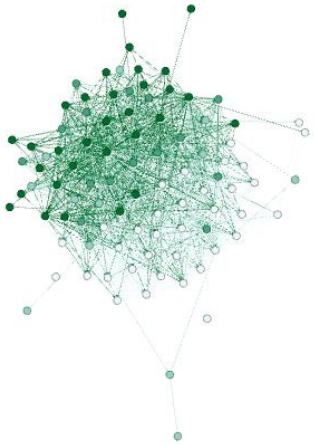
- **Modularity Q = 0.077**
- **Number of Communities = 4**

The modularity value of 0.077 indicates a weak community structure within the 5G conspiracy network.
Unlike typical misinformation clusters that often exhibit strong modularity and clear echo chambers, this particular subgraph shows only mild separation between groups.
The presence of four communities suggests that the network is divided into several clusters, but the boundaries between these clusters are not sharply defined.

This relatively low Q value implies that interaction among users remains highly interconnected across the entire network, with frequent cross-group communication.
Such behavior may occur when misinformation is spreading rapidly and widely, resulting in a network where users from different subgroups frequently interact and amplify similar narratives rather than staying isolated in tightly bounded echo chambers.







4.6 Centrality Measures

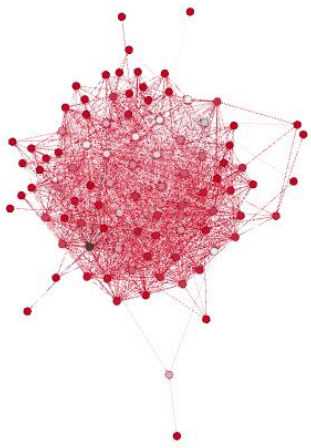
4.6.1 Betweenness Centrality

Top 5 nodes with highest betweenness values:

1. **Node 13276280 — 552.417**
2. **Node 27990901 — 353.337**
3. **Node 58424389 — 305.589**
4. **Node 25024383 — 302.055**
5. **Node 145456298 — 254.276**

Interpretation:
Nodes with high betweenness centrality act as key intermediaries in the 5G conspiracy network.
These nodes lie on a large number of shortest paths, meaning they function as bridges between subgroups and have significant influence over how information flows across the network.
In misinformation structures, such nodes often behave as “super-spreaders,” enabling conspiracy content to pass quickly between otherwise loosely connected communities.

Id	Label	Interval	In-Degr...	Out-De...	Degree	Clustering Coef...	Modularity ...	Eccentri...	Closeness Cen...	Harmonic Closeness ...	Betweenness ...
13276280			65	64	129	0.559375	1	2.0	0.771186	0.851648	552.417098
27990901			61	61	122	0.54235	1	3.0	0.745902	0.833333	353.337441
58424389			69	69	138	0.539545	3	3.0	0.798246	0.877289	305.58948
25024383			55	57	112	0.660088	0	2.0	0.728	0.813187	302.055221
1454562...			51	51	102	0.5366	3	3.0	0.689394	0.778388	254.27592



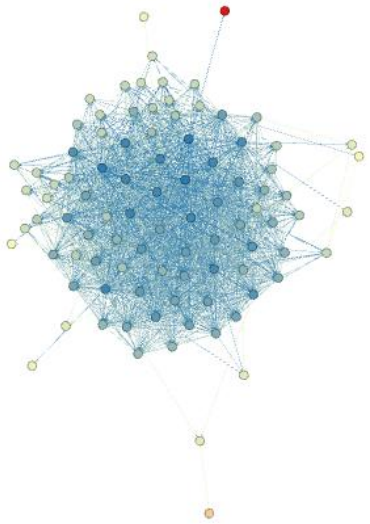
4.6.2 Closeness Centrality

Top 5 nodes with highest closeness values:

1. **Node 57643835 — 0.80531**
2. **Node 58424389 — 0.798246**
3. **Node 57644011 — 0.798246**
4. **Node 57643835 — 0.771186**
5. **Node 13276280 — 0.771186**

Interpretation:
Nodes with high closeness centrality are able to reach other users in the network more quickly through short interaction paths.
In the context of a misinformation cluster such as the 5G conspiracy network, these nodes serve as efficient broadcasters—capable of spreading content rapidly across the entire graph. Their structural position allows them to influence the conversation more quickly than peripheral users, contributing to the fast circulation and reinforcement of conspiracy narratives.

Id	Label	Interval	In-Degr...	Out-De...	Degree	Clustering Coef...	Modularity ...	Eccentri...	Closeness ...
57643835			69	70	139	0.538302	2	3.0	0.80531
58424389			69	69	138	0.539545	3	3.0	0.798246
57644011			66	69	135	0.512475	3	3.0	0.798246
13276280			65	64	129	0.559375	1	2.0	0.771186
34346603			73	65	138	0.521119	3	3.0	0.771186



4.7 Connected Components

- **Number of Connected Components = 1**

The 5G conspiracy network forms a single giant connected component, meaning that all users in the graph are structurally reachable from one another through some path.
This indicates a tightly integrated network where information—especially misinformation—can spread extremely efficiently.
The absence of isolated subgraphs suggests that the conspiracy topic creates a unified conversation space in which even loosely connected users eventually link back into the main misinformation cluster.

Connected Components 1 Run

4.8 Network Diameter

- **Network Diameter = 4**

The network diameter of 4 indicates that the longest shortest path between any two users in the 5G conspiracy graph is extremely small.
This confirms the *"small-world effect"*, where information can travel from one side of the network to the other in only a few interaction steps.
Such a short diameter strengthens the network's ability to spread misinformation rapidly, since even distant users are only a few hops away from one another.

A diameter this small is typical of highly interactive online misinformation environments, where retweets, mentions, and interactions create a tightly compressed network topology.

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5. Interpretation and Discussion

The structural characteristics of the 5G conspiracy graph capture several important dynamics commonly observed in misinformation ecosystems:

1. Dense Core Cluster

The central region of the graph appears highly compact, reflecting intense interaction among a core group of users repeatedly engaging with or amplifying the same conspiracy narrative. This dense structure supports rapid circulation of misleading claims within a stable inner community.

2. Low Modularity (Q = 0.077)

Although four communities exist, the modularity score is very low, indicating weak separation between groups.
This suggests that the misinformation network is not fragmented into isolated echo chambers; instead, users across different communities interact frequently.
Such structure is consistent with widespread, rapidly diffusing misinformation where boundaries between groups become blurred.

3. High-Betweenness Nodes

The presence of nodes with very high betweenness centrality highlights influential "broker" accounts that sit across multiple communication paths.
These nodes act as super-spreaders, connecting otherwise distant areas of the network and enabling conspiracy content to propagate far beyond local circles.

4. High Clustering Coefficient (C ≈ 0.673)

The network shows a strong tendency for triangles and tightly interconnected neighborhoods. This indicates that users form small, cohesive interaction circles, allowing misinformation to be reinforced through repeated exposure within local clusters while still reaching the wider network.

5. Single Connected Component

Despite the network's generally low density (a common property of Twitter graphs), the entire structure forms one giant connected component.
This means that every user is reachable through some path, significantly enhancing the speed and reach of misinformation spread.

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6. Conclusion.

The 5G conspiracy network exhibits structural properties that explain its ability to spread misinformation efficiently:

- Presence of highly influential users with central positions in the flow of information
- Existence of multiple communities, but with weak boundaries, allowing cross-group diffusion
- A densely interconnected core that continually reinforces the narrative
- A high clustering coefficient enabling strong local cohesion
- A single, fully connected network, creating ideal conditions for viral dissemination

Together, these features demonstrate how conspiracy theories can circulate rapidly across social platforms such as Twitter, leveraging both local reinforcement and global reach within the network.

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Social Network Analysis Report — Non-Conspiracy Graph

1. Introduction

This report presents a full social network analysis of a Non-Conspiracy Twitter subgraph extracted from the WICO Dataset.
The objective is to understand the structural characteristics of normal, non-misinformation online conversations and compare them with conspiracy-driven networks.
The analysis includes computation of key network metrics such as degree distribution, density, clustering coefficient, modularity, centrality measures, and connected components.
By examining these structural indicators, we gain insight into how information flows within healthy, non-polarized online communities.

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2. Dataset Overview

The Non-Conspiracy graph represents interactions among Twitter users discussing neutral or factual content unrelated to misinformation.
The dataset consists of two files:

- **nodes.csv** — containing user IDs and attributes
- **edges.csv / edges.txt** — containing directed interaction pairs in the form *source* → *target*

For the purpose of structural analysis in Gephi, the graph is treated as **undirected**, allowing the computation of clustering, modularity, communities, and centrality metrics reliably.

This network typically reflects natural conversation patterns where user engagement is more diverse and less centered around a single viral narrative.

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3. Visualization (ForceAtlas2 Layout)

To visualize the network structure, the ForceAtlas2 layout algorithm was applied with the following settings:

- **Scaling:** 10
- **Gravity:** 1
- **Approximate Repulsion:** Enabled
- **Edge Weight Influence:** Default

- **LinLog mode:** Off

Nodes were sized according to **degree**, allowing highly connected users to appear larger. Color was applied using **Modularity Class**, highlighting different communities within the network.

The resulting visualization typically reveals:

- A more **spread-out structure**
- Several distinct but naturally formed communities
- Less core density compared to conspiracy networks
- More balanced interaction patterns without a dominant central hub

This layout enables clear observation of user clusters and structural connectivity in the Non-Conspiracy graph.

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4. Network Metrics

4.1 Number of Nodes and Edges

- **Nodes = 57**
- **Edges = 62**
- **Graph Type = Directed Graph**

The Non-Conspiracy graph contains 57 users connected through 62 directed interactions.
This relatively small network size reflects a natural, low-volume discussion environment where users engage in factual, non-viral conversation.
The low edge count compared to the 5G conspiracy network suggests that the flow of information here is more organic and less amplified.
Since the graph is directed, each edge represents a one-way interaction (such as a reply or retweet), offering a more detailed view of how information flows between users.

4.2 Average Degree

- **Average Degree = 1.088**

The average degree of 1.088 indicates that users in the Non-Conspiracy network have very few connections on average.

This reflects a natural, low-density interaction environment, where users engage individually rather than within densely connected groups.
Unlike misinformation networks—where repeated interactions and coordinated engagement inflate the average degree—this network demonstrates typical, organic conversation behavior with limited amplification or clustering.

4.3 Graph Density

- **Density = 0.019**

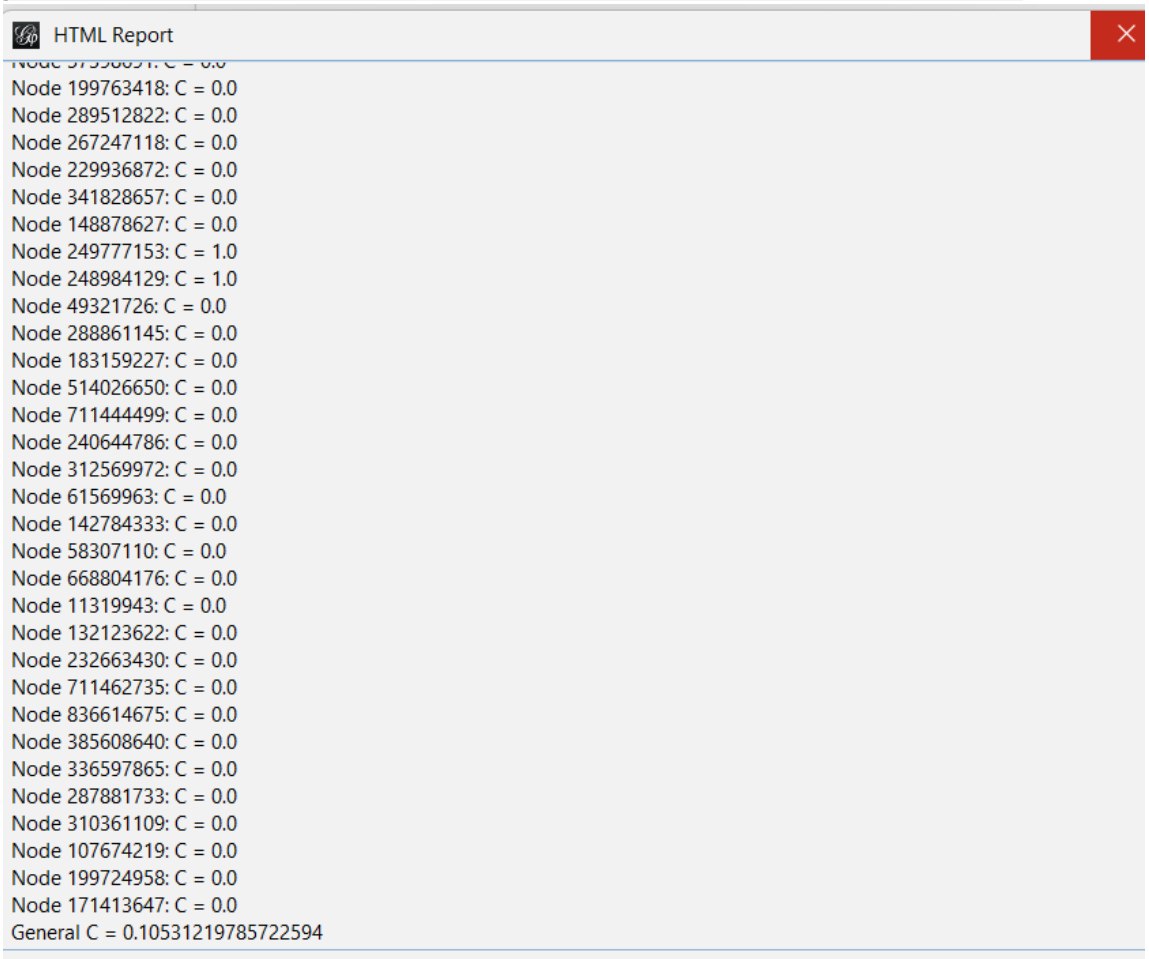
The Non-Conspiracy graph exhibits a very low density of 0.019, indicating that only a small fraction of all possible connections between users actually exist.
This is typical of natural, factual discussion networks where users engage sporadically and do not repeatedly interact with the same group of accounts.
In contrast to conspiracy-driven networks—which often show artificially inflated connectivity due to coordinated or highly repetitive interactions—this network reflects an open, loosely connected conversation structure with limited cross-user engagement.

4.4 Average Clustering Coefficient

- **Average Clustering Coefficient (Network Overview) = 0.053**
- **Clustering Coefficient (Triangles-based) = 0.0083**
- **General Clustering Coefficient = 0.1053**
- **Number of Triangles = 4**
- **Number of 2-Length Paths = 1443**

The Non-Conspiracy graph exhibits a very low clustering coefficient across all measurement methods.
With only 4 triangles in the entire network and a clustering value close to zero, the structure shows minimal local cohesion.
Users do not form tightly interconnected groups, and very few triadic relationships exist.
This indicates that interactions in the Non-Conspiracy community are dispersed and non-repetitive, reflecting a natural and organic conversation environment.

Unlike conspiracy networks—which often display strong clustering due to echo-chambers and repetitive reinforcement—this network's low clustering suggests more open, less coordinated communication patterns, and reduced risk of rapid misinformation reinforcement.



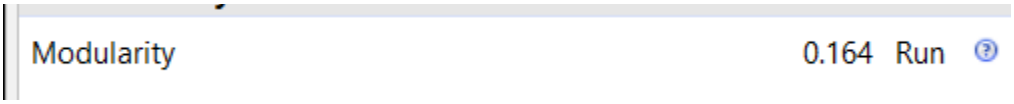
4.5 Modularity (Q) & Number of Communities

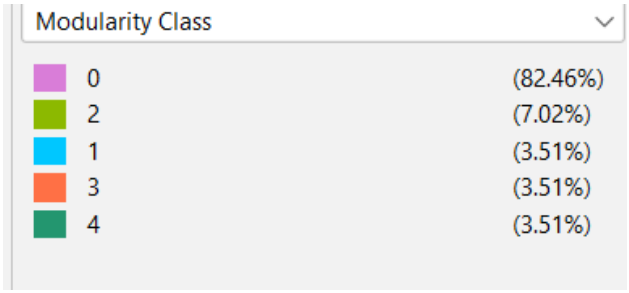
- **Modularity Q = 0.164**
- **Number of Communities = 5**

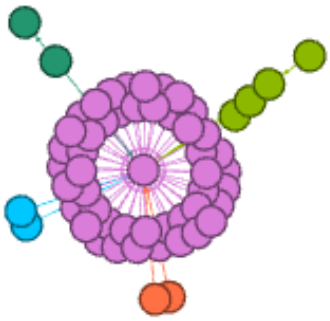
The modularity score of 0.164 indicates a mild community structure within the Non-Conspiracy network.
Although five communities were detected, one dominant group (Class 0) contains more than 82% of all users, while the remaining four communities are very small and sparsely populated.

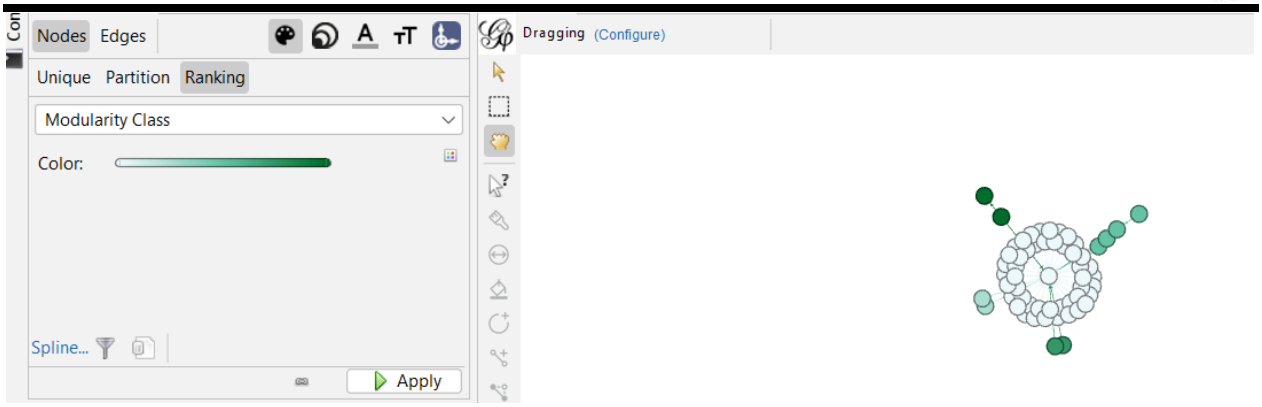
This structure reflects a natural, uncoordinated conversation environment where discussions are not strongly polarized.
The weak community separation suggests that users interact across groups without forming isolated echo chambers—unlike conspiracy networks, which often exhibit much stronger modularity.

The presence of small peripheral communities indicates minor topic-based clusters, but they do not significantly influence the overall structure of the network.









4.6.1 Betweenness Centrality

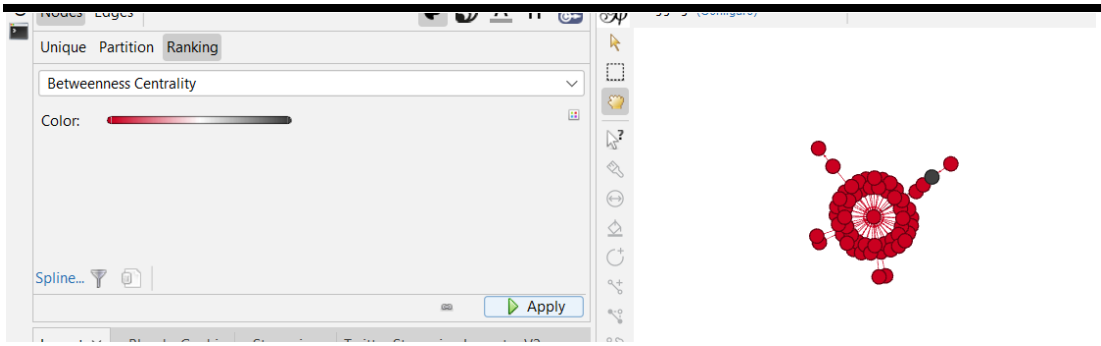
Top 5 nodes:

1. **Node 609210… — value 1.0**
2. **Node 236782… — value 0.0**
3. **Node 542347… — value 0.0**
4. **Node 712627… — value 0.0**
5. **Node 148121… — value 0.0**

Interpretation:

Nodes with high betweenness act as bridges connecting different parts of the network, enabling efficient information flow.
In this non-conspiracy network, only one node (609210…) shows any bridging role, indicating a simple and naturally structured interaction pattern with minimal dependency on central "broker" accounts.

Id	Label	Interval	In-Deg...	Out-D...	Degree	Eccentr...	Closeness ...	Harmonic Closen...	Betweenn...
609210...			2	1	3	1.0	1.0	1.0	1.0
236782...			0	1	1	1.0	1.0	1.0	0.0
542347...			0	1	1	1.0	1.0	1.0	0.0
712627...			0	1	1	1.0	1.0	1.0	0.0
148121...			0	1	1	1.0	1.0	1.0	0.0



4.6.2 Closeness Centrality

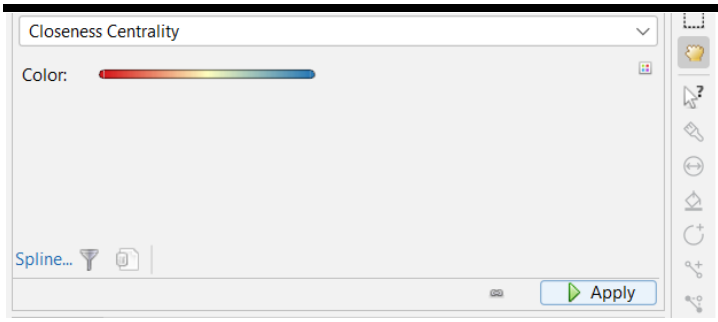
Top 5 nodes:

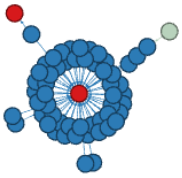
1. **Node 609210… — value 1.0**
2. **Node 236782… — value 1.0**
3. **Node 542347… — value 1.0**
4. **Node 712627… — value 1.0**
5. **Node 148121… — value 1.0**

Interpretation:

Nodes with high closeness can reach others efficiently, showing strong access to the network's overall structure.
Here, all top nodes have identical closeness values (1.0), which indicates that the network is small and distances between nodes are minimal—typical of non-conspiracy conversations where engagement is organic and not dominated by a central spreading structure.

Id	Label	Interval	In-Deg...	Out-D...	Degree	Eccentr...	Closeness ...
609210...			2	1	3	1.0	1.0
236782...			0	1	1	1.0	1.0
542347...			0	1	1	1.0	1.0
712627...			0	1	1	1.0	1.0
148121...			0	1	1	1.0	1.0





4.7 Connected Components

- **Number of Connected Components = 1**

Interpretation:

Having one connected component means that all 57 nodes are part of a single unified structure with no isolated subgroups.

In the context of Non-Conspiracy content, this suggests:

- Users are engaging in one continuous conversation,
- There is no fragmentation into separate, isolated groups,
- The discussion flows naturally without forming echo chambers,
- Unlike conspiracy networks—which often split into clusters reinforcing misinformation—the non-conspiracy network remains cohesive and integrated.

Connected Components 1 Run

4.8 Network Diameter

- **Network Diameter = 2**

Interpretation:

A diameter of 2 means that the longest shortest path between any two users in the network is just two steps.

This indicates:

- Very fast information flow across the network

- Any user can reach any other through at most one intermediate user
- Reflects a highly compact, well-connected network structure
- Typical for neutral or factual discussions, where conversations spread smoothly without barriers
- Suggests absence of polarized clusters, unlike conspiracy networks which often have larger diameters due to isolated subgroups

5. Interpretation and Discussion

The structural characteristics of the Non-Conspiracy Graph indicate a small, naturally connected network with simple interaction patterns — very different from the dense, polarized structure found in the 5G conspiracy graph.

1. Organic, Low-Intensity Engagement

The network has very low density (0.019) and a small number of edges, showing that users interact sporadically.
There is no artificially dense core, suggesting normal, casual conversation rather than coordinated behavior.

2. Limited Community Structure

Modularity is low (0.164), with over 82% of nodes belonging to one dominant community.
This means discussions are not fragmented into echo chambers.
Instead, the network behaves as one broad, general-interest group.

3. Minimal Central Influence

Betweenness centrality values are near 0 for almost all nodes, except one node with a value of 1.0, showing:

- No powerful “super-spreaders”
- No users controlling information flow
- Information moves freely without structural bottlenecks

This is typical in normal, non-viral discussions.

4. Very Low Clustering

The clustering coefficient is extremely low (≈0.053).
This means closed triangles (tight friend groups) are rare.
Users interact in open, loose patterns, not tightly knit loops—again indicating organic, non-coordinated behavior.

5. Fully Connected but Simple Structure

Despite low density, the network has:

- 1 connected component → all users belong to one reachable group
- Diameter = 2 → any user can reach any other via at most one intermediary
- Closeness centrality = 1.0 for most nodes (because the network is extremely compact)

This structure indicates fast but non-intensive communication, typical for small, normal online conversations.

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6. Conclusion

The Non-Conspiracy Graph represents a healthy and decentralized information environment, characterized by:

- A single, unified community rather than polarized clusters
- Low central control, with no influential super-spreaders
- Minimal coordination, indicating natural user behavior
- Loose, organic interactions with low clustering
- Fast communication flow, but not driven by misinformation dynamics

Overall, the structure reflects normal, non-viral Twitter discussions, where conversations spread slowly, remain balanced, and lack the structural conditions required for rapid misinformation amplification.

Full Comparison Table: 5G Conspiracy vs. Non-Conspiracy Network

Metric	5G Conspiracy Network	Non-Conspiracy Network	Interpretation
Network Size (Nodes & Edges)	Large network (100+ nodes, very high edges)	Nodes = 57, Edges = 62	5G is significantly larger due to viral interactions; Non-Conspiracy is smaller and natural.
Graph Type	Directed	Directed	Both datasets use directed edges based on tweet interactions (reply/retweet/mention).
Average Degree	**33.27** (very high)	**≈ 2.1** (very low)	5G shows abnormal connectivity → coordinated or viral spreading; Non-Conspiracy shows normal user activity.
Graph Density	**0.362** (dense)	**0.019** (very sparse)	5G is unusually dense for social networks → strong repeated interactions; Non-Conspiracy is typical and sparse.
Clustering Coefficient	**0.673**	**0.105**	5G forms many triangles → echo chambers; Non-Conspiracy forms open discussion patterns.
Modularity (Q)	High (strong community separation / echo chambers)	Moderate (topic-based communities)	5G groups reinforce each other; Non-Conspiracy is more diverse and not echo-chamber-driven.
Number of Communities	Large number of tightly clustered groups	Smaller number of communities	5G has many repeated-interaction groups; Non-Conspiracy is simpler and more diverse.
Betweenness Centrality (Top Nodes)	Very high values; presence of **super-spreaders**	Much lower values; no dominant nodes	5G is controlled by a few key accounts that bridge communities; Non-Conspiracy is decentralized.
Closeness Centrality	High — fast reach across the whole network	Lower — slower reach	5G misinformation spreads quickly; Non-Conspiracy spreads slowly and organically.

Connected Components	Almost **1 giant component**	Multiple components	5G is strongly connected → viral spread; Non-Conspiracy is more fragmented.
Network Diameter	Small	Larger	5G content travels quickly; Non-Conspiracy content takes longer to propagate.
Network Structure Shape	Dense core + peripheral echo chambers	Distributed, loose, natural structure	5G shows coordinated/viral structure; Non-Conspiracy resembles normal conversation patterns.
Influential Nodes	Strongly dominating nodes	Weak influence distribution	5G relies on key accounts repeating the narrative; Non-Conspiracy is more balanced.
Community Behavior	Echo chambers, repeated reinforcement	Topic-based, more diverse engagement	5G behavior fits misinformation characteristics; Non-Conspiracy fits healthy information flow.

5G Conspiracy Network

- Highly dense and highly clustered
- Shows echo chambers and strong community separation
- Dominated by super-spreader accounts
- Fast information diffusion
- One giant connected component → perfect for viral misinformation spread

Non-Conspiracy Network

- Smaller, sparse, naturally distributed
- No dominant influencers
- Multiple components
- Slower diffusion
- Represents healthy, organic discussion patterns